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ABSTRACT

Working on the assumption that when reading comprehension is viewed from a constructivist framework, where meaning grows and changes as the text progresses, categorization into comprehension levels such as literal and inferential will be misleading, two third grade standardized multiple choice test items were selected from a larger body of test items and administered to 24 third grade students. A procedure was used allowing a view of each reader's growing and changing text world, from locally developed envisionments that were appropriate meanings-in-process through the final envisionments the readers had negotiated after completing the entire passage. The test questions had been previously analyzed to determine question type (local/global and literal/inferential), and analysis of student question-answering strategies permitted comparisons of the knowledge sources used across question types. The results indicated that students did not act on the assumptions used to make literal/inferential distinctions, and therefore interpretations of student performance on these measures did not reflect the meanings the students actually generated. (Author/HOD)

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LEVELS OF QUESTIONING: AN ALTERNATIVE VIEW

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Abstract

This study suggests that when reading comprehension is viewed from a constructivist framework, where meaning grows and changes as the text progresses, categorization into comprehension levels such as literal and inferential is misleading.

Two third grade standardized multiple-choice test items were selected from a larger body of test items and administered to 24 third grade students using a procedure which allowed a view of each reader's growing and changing text world, from locally developed envisionments that were appropriate meanings-in-process through the final envisionments the readers had negotiated after completing the entire passage. The test questions were previously analyzed to determine question type (local / global and literal / inferential), and analyses of student question-answering strategies permitted comparisons of the knowledge sources used across question types.

The data indicate that students do not act on the assumptions upon which the literal/inferential distinctions are based, and therefore interpretations of student performance on these measures do not reflect the meanings the students actually generate. Further, the local/global distinction seems a promising new direction.

LEVELS OF QUESTIONING: AN ALTERNATIVE VIEW

We will argue here that when reading comprehension is viewed as a constructive process, where meaning grows and changes as the text progresses, the traditional categorization of comprehension into literal and inferential levels is misleading and unproductive; the processes that students use to answer such questions do not reflect the assumptions upon which these distinctions are based.

The present study grows out of earlier work (Langer, in press) that examined students' performance on standardized multiple-choice reading comprehension test items. The earlier study suggested that although successful performance on test items was related to comprehension ability, the tests themselves neither measured the processes involved in the development of meaning from a text nor evaluated an individual's ability to manage these processes. When one views reading as a process during which meaning develops and grows as the reader progresses through a passage, the variety of hierarchies traditionally used to formulate the questions may be totally irrelevant to the comprehension (or meaning-making) process.

The issue is not whether the taxonomies should focus on literal/interpretative or textually implicit/explicit categorization systems, nor whether they should be based on hierarchies of conceptual complexity or focus on aspects of critical thinking. Rather we will argue that all of these approaches are too heavily text-based, producing comprehension questions that do not reflect the cognitive complexities real readers encounter as they build meaning throughout the reading of a passage.

If comprehension assessment is to do more than rank order our students in terms of overall reading achievement, then it needs to be rooted in the reader's growing understanding of what the entire passage is about--to recognize that meaning derived from a particular portion of a text is shaped by how earlier segments were interpreted and continues to change based on interpretations of later segments. If the reader's growing and changing text world fails to be considered as an integral part of the comprehension process, the frameworks used to generate questions are likely to misrepresent, or entirely miss, the comprehension process.

In this paper we will review some widely used models of the complexities in reading comprehension. We will look at some older notions that have influenced the generation of comprehension questions as well as some more recent models

used as guides for comprehension testing, comprehension assessment, and comprehension instruction. We will then present the theory upon which the present study was based, describe the procedures and results, and finally, present a general discussion of the findings.

Questioning

Since the early 1900s reading comprehension has been regarded as a complex mental activity that involves a variety of cognitive behaviors. The behaviors are assumed to vary in response to the specific content of the text and the degree to which information needs to be abstracted in order to arrive at a particular kind of understanding. Questions designed to assess the range of comprehension difficulties have generally been based on the degree to which the information being tested is directly available within the text or needs to be inferred through processes of abstraction or generalization.

Most current models of comprehension difficulty roughly parallel Bloom's more general taxonomy of levels of cognitive functioning (i.e., Bloom 1954, 1964); though specific categories may be collapsed and labels may differ, the concepts and ideas gained from reading a text are seen to progress in complexity from knowledge (facts and definitions) to comprehension (paraphrase, infer, imply), to application, to analysis, to synthesis, and finally to

generalization or evaluation.

Influential early models of reading comprehension developed by Gray (1919) and Davis (1944, 1968) suggested similar hierarchies of difficulty. Gray listed eight skills which he identified as components of reading comprehension. Those related to the "levels" of questioning under consideration are: 1) to read for the purpose of giving a coherent representation, 2) to determine the central thought, 3) to select a series of closely related points and their supporting details, 4) to secure information that will aid in solving a problem, and 5) to discover new problems in regard to the topic. Davis identified the following cognitive abilities which his studies indicated were related to reading comprehension: 1) knowledge of word meaning, 2) the ability to follow the organization of a passage, 3) the ability to select the main thought of a passage, 4) the ability to answer questions that are not specifically answered in the passage, 5) the ability to answer questions that are answered in a passage but not in the words in which the question is asked, and 6) the ability to draw inferences. Each model includes factors that are close to the surface text as well as those that are more abstract, and both influenced later work in the field.

At the present time, three levels of difficulty are frequently used to generate questions for the assessment of

reading comprehension: literal (factual), interpretive (inferential), and evaluative (applicative). Similar levels of comprehension are presented in textbooks on the teaching of reading comprehension, as guides to the comprehension behaviors that students must learn (e.g. Estes and Vaughan 1978, Herber 1978, Ruddell 1974, and Zintz 1970). Although textbooks differ in the extent to which they view the three "levels" as rigidly hierarchical, all imply that the ability to comprehend at one level is often essential to comprehension at a higher level. A brief look at two of these textbooks will illustrate the widespread acceptance of this taxonomy of levels of comprehension, for both teaching and testing.

Herber (1978), in his widely used textbook on content area reading, describes three levels of comprehension: literal, interpretive, and applied. His definition of literal understanding includes the identification of factual material and knowing what the author said. Interpretive understanding involves inferring relationships among the statements and knowing what the author meant. Applied understanding involves developing generalizations which extend beyond the assigned material. Herber suggests that the reader takes information derived from the literal and interpretive levels and applies that knowledge to already existing knowledge, thereby deepening understanding. Herber

further states that it is necessary to master understanding at one level before proceeding to the next. He cautions that based on the particular content, the teacher must decide the appropriate levels of understanding students will need.

Similarly, Ruddell (1974), on the basis of his communication model of reading comprehension, identifies three comprehension levels: factual, interpretive, and applicative. He suggests these should be viewed as forming related comprehension competencies to be identified for instructional purposes. Ruddell cautions that these levels are not to be considered as rigidly hierarchical. He states that that although identification of details at the factual levels appears to be essential in order to locate the main idea and predict possible outcomes at the interpretive level, identification of main idea at the interpretive level is not a prerequisite for predicting outcomes at that same comprehension level (p. 381).

Constructivist Models

During the past fifteen or so years, our theories of reading have begun to place more stress on the interactive nature of the reading process (Guthrie 1981; Langer and Smith-Burke 1982; Spiro, Bruce and Brewer 1980), and have begun to consider the relationships between what the reader

brings to the text and the inherent complexities of the text itself. Although different in many other ways, both constructivist (Langer, in press, Rumelhart 1975 and 1980, Spiro 1980), and semiotic (Iser, 1976) views of reading comprehension suggest that reading is not simply a text-based activity, but an interactive process in which reader and text both contribute to the meaning that evolves. In contrast to this dynamic view of meaning construction, the traditional "levels" of reading comprehension seem to lead to very simple predictions about reading behavior (i.e., that a "literal" question will be answered by reference back to directly stated points in the text and an "interpretive" question can be answered by identifying relationships between and among ideas). Such "levels" suggest that meaning complexities reside in the text, and imply that the reader needs to learn a variety of ways of "unlocking" text messages. Herber (1978), for example, carefully states that the higher two levels of comprehension are influenced by prior knowledge of and experience with the topic, but he nevertheless views interpretive comprehension as primarily a result of intertext (intrinsic) relationships which then can, through synthesis with background knowledge, lead to the development of a new extrinsic relationship that has a scope beyond the actual reading selection.

However, if the complexity of ideas is a function of

the conjunction of the reader and the text, as more recent research suggests (Anderson 1977, Goodman and Goodman 1978, Polanyi 1966, Schank and Abelson 1977, Rumelhart 1977, Spiro 1980), this must be considered more directly in any categorization or "leveling" of comprehension complexity. Pearson (1978), in his recent and widely used model of comprehension complexity, attempts to make more direct links between readers' knowledge and text knowledge. His model treats all but directly stated information that can be "lifted" out of the text as in some way implicit rather than explicit; almost all text messages, however simple they may seem to be, are necessarily interpreted. Pearson's comprehension categories are based on relationships between questions and answers, and are identified by the data source that must be used by the reader to generate a correct response. A question-answer relation is textually-explicit if both question and answer are derivable from the text, and if the relationship between question and answer is explicitly cued by the language of the text. A question-answer relationship is textually-implicit if both question and answer are derivable from the text but there is no logical or grammatical cue tying the question and answer, and the answer is plausible in light of the question (reading between the lines). Finally, a question-answer relationship is scriptally-implicit when a plausible

nontextual response is given to a question derivable from the text (reading beyond the lines). While this view of comprehension complexity is clearly more reader-based than its predecessors, it still treats meaning as relatively static and does not account for the ways in which comprehension develops and changes during the act of reading.

In order to look at the extent to which comprehension questions trace the development of meaning during the reading process, it is necessary to have a system for describing the development of meaning in particular texts. The system adopted here is based on an analysis of a reader's changing "envisionment" of the text world; this notion is elaborated in the section that follows.

The Developing Envisionment

This study of comprehension questioning grows out of a body of work done with Fillmore and Kay (note 1) which looked, in part, at how the content (and its presentation) in a test question relates to the text-world or envisionment a reader develops at any point in progressing through a text. An envisionment is the primary "dynamic" through which the reader experiences the "message." Much more than mere "imagery," the envisionment connotes the total understanding a reader has developed at any point in time during the reading of a particular text. The envisionment established

after reading any given portion of the text is shaped by how earlier segments were interpreted and continues to develop and change in light of later segments. These changing envisionments are a record of the "text world" the reader creates while making sense of the text; they are a result of the reader's process of interpretation.

During any actual reading experience, a reader develops many "local" envisionments; these change as new information from the text and new inferences from the reader lead to changes in the reader's understanding of the text that has been read. The series of local envisionments lead towards, but are not the linear components of, the final integrated envisionment--the envisionment the reader is left with after processing through and interpreting the text as a whole. This distinction separates "local" from the "final envisionment" or text-world the reader has created and possesses after having read the entire passage.

A system of analysis was devised to keep track of the changing envisionments--those developed within the text and those constructed by real readers. The analysis is text specific; a particular text is analyzed linearly (clause by clause), tracing the changing interpretations that could justifiably be made in the process of comprehending that text for that purpose. The analysis of a particular text, then, leads to an abstraction of that knowledge and those

strategies likely to be called on for a particular interpretation of a particular text. The kinds of knowledge depicted in the analysis of any particular text are determined by the content, the overall structure, and the internal language (or grammar). The analysis conveys a dynamic version of reader-text interaction that codifies a finite number of meaning expectations and integrations; these interpretations constitute the developing envisionment up to any particular point in the text. This analysis is not to be confused with a description of the strategies a "good" reader uses or should use. Rather, it exemplifies an array of operations deemed useful in processing a specific text for a specific purpose (see Fillmore 1981, Kay 1981), and is used as a a dynamic "possible-strategy" base from which, through a series of related probing questions, to determine what real readers actually do.

The analysis distinguishes among three sources which simultaneously influence the developing envisionment: genre, content, and text. The influence of Genre (Gn) is evident as early as the first sentence, where expectancies are set up about the events and their resolutions. New Content (Co) is introduced throughout a passage, leading towards a refinement of the various ideas being discussed or implied. At the same time, readers refine their ideas based on the linguistic material of the Text (Tx) itself,

including such features as its syntax, vocabulary, and causal connectives.

In responding to elements within these three envisionment sources, readers perform a number of different cognitive operations in the process of developing, negotiating, and arriving at meaning. The system of analysis tracks six general operations: questions, expectations, hypotheses, assumptions, schemata, conclusions, and validations. Definitions follow.

1. Questions (Q) - uncertainties the reader has at any point in reading
2. Hypotheses (H) - predictions the reader makes about what the genre is, about what the function of a particular piece of text is, or about the answer to a question about a certain portion of the text
   (H) predictions the reader makes about what will be "said" in succeeding portions of the text
3. Assumptions (Ass) - meanings the reader takes for granted without textual evidence
4. Schemata (Sch) - basic memory structures evoked about the genre, content, or text
5. Conclusions (Con) - information which substantiates a hypothesis
6. Validations (Val) - proof that a hypothesis was correct

or fulfilled

A brief example of a detailed analysis of the opening segment of one test passage, Strange Machine, is presented in Figure 1.

(insert figure 1 about here)

In Figure 1, the left column presents the detailed analysis of the possible sources and operations leading towards a developing envisionment. We also developed probe questions that allowed us to trace parallels between the text analysis and the ways in which envisionments were developed by real readers. The probe questions developed for this particular text segment appear in the right hand column in figure 1.

The Present Study

Conceptualization of the envisionment, the sources of the envisionment, and the operations leading towards the development of the envisionment made possible the investigation of test-item construction and the sources of real readers' comprehending and question-answering strategies. The present study 1) examined in detail two passages from popular reading comprehension tests to determine the knowledge sources (local or final envisionments) upon which the test questions were based; 2) examined the knowledge sources students used when answering

those questions; and, 3) compared classification of questions in terms of their focus on local or final envisionment, with a classification of the same questions in terms of the more traditional levels of comprehension.

The Sample

Data were gathered as part of the two year project with Fillmore and Kay. Test items were selected from norm-based standardized reading comprehension tests (grades 3 and 5) that were in wide use in the United States. Two third grade test items were selected from the larger body of third and fifth grade test items examined during the project and were typical of the many items that were reviewed. Strange Machine is a passage from the CTBS McGraw-Hill Comprehensive Test of Basic Skills, Level 1, Form S, 1974 (see figure 2) and Bronco is included in the Gates MacGinitie Primary C, Form 1 test, 1965 (see figure 3).

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insert figures 2 and 3 about here

Twenty four third grade students were randomly selected from a middle class elementary school in Oakland, California. Due to our focus on comprehension test items, students with decoding problems were excluded from participation. The mean percentile on the California Test

of Basic Skills was 70 with a range from the 42nd to the 99th percentile.

Procedures

Each text (test item) studied was segmented and analyzed using the system previously described, to trace in detail the sources of the developing envisionments. Parallel probe questions were developed to trace the developing envisionments as real readers progressed through a reading of the test item. Both the analyses and the probe questions were developed by two research assistants working cooperatively, and were then presented to the larger group of project staff members for negotiation and modification.

Each previously analyzed test passage was individually presented to each of the 24 students in meaning segments corresponding to those used in the notation to describe the developing envisionment. After a student had read a segment, the probe questions related to that segment were asked. In presenting the text, the printed words of each segmented text were blocked out and only those segments the reader had already read were left uncovered. After reading the passage segment by segment, the students were asked to read the first of the test questions following the passage, to guess what the answer might be and then to look at each choice separately, tell whether they thought it was a "good" choice or not and why, and select the best answer.

Analyses

The analyses can be characterized as a series of descriptive studies carried out in the tradition of linguistic inquiry whereby our observations of readers and their responses to the strategy probes were used to inform the developing analyses of texts, questions, and readers. The analysis of students' responses permitted us to look for patterns in the meaning sources that the students tended to use in formulating their answers to questions we judged as tapping information contained in either their local or final envisionments.

Each question accompanying the test passages was categorized as requiring knowledge from either a local envisionment or from the final integrated envisionment (see Figures 2 and 3 for local/final envisionment designations). Local questions were defined as those based on information that is integrated into the reader's understanding as the passage develops but that is not an integral part of the final envisionment. Global questions were defined to be questions tapping final integrated envisionments, based on information provided by the entire text.

Each local and global question was also categorized by the more traditional question types to permit comparison among alternative methods of categorization (see Figure 4).

For this particular set of questions, the categorization as local or global was sufficiently distinct from that as literal or inferential to allow further analyses. Categorization as textually explicit or textually implicit did not yield enough variation to be pursued further in this sample of questions.

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insert figure 4 about here

Tape recordings of performance during reading and answering the test questions were analyzed to determine whether they were drawing on local or final envisionments to arrive at their responses to each question. Since some understandings developed early in a passage also appeared (appropriately or inappropriately) in final envisionments, the students were attributed with using a local envisionment source only if a) that concept had not been reported to be contained in their final envisionment, and b) it had been reported to appear in an earlier local envisionment.

Results across questions were analyzed using repeated measures multivariate analyses of variance, contrasting main effects for local/global and literal/inferential questions. In all cases, the main effects were estimated after allowing for the other main effects in the ANOVA model.

Results and Discussion

Results of these analyses indicated many complexities

in the knowledge sources the students used to respond to the test questions. As we had expected, the traditional question categories were not particularly helpful in describing students' responses to particular questions. Although literal or textually explicit questions are usually assumed to be simple (because the answers are directly stated in the text), we found that many were in fact difficult for the students to answer. These questions sometimes required the readers to peel away layers of integrated meaning to arrive at the "correct" response, or to simply resort to a visual match with the graphic features in the text. Rather than relying on these text-based systems, we found that comprehension could be more accurately addressed by looking at the reader's constructed text-world, in terms of local or final integrated envisionments.

To develop these points, we will first present detailed analyses of students' responses to the two test passages, and then summarize results across questions and passages.

Detailed Analyses

The descriptive data presented in this section have been selected to illustrate the kinds of strategies students used as they responded first to an open-ended version and then to the multiple-choice version of each test question.

Each passage will be briefly described, together with the students' varied final envisionments of the text, their understandings and misunderstandings while reading. This will be followed by a detailed account of their responses to the open-ended and multiple-choice version of each question, as well as their reported reasons for those responses. These data will allow us to describe in considerable detail the reasoning strategies the students used in arriving at responses to comprehension questions.

Strange Machine. The Strange Machine passage (see figure 2) is about the appearance of an early version of the stereo record player (the "strange machine") in 1877. The information is presented in a riddle format (encouraging the reader to guess the name of the strange new machine) that includes a rapid succession of seemingly simple schemata (Sch) introducing parts of the machine (e.g. mouthpiece, handle, tin, tubes). Rather than offering quick resolutions to the hypotheses (H Co) that are generated, the density of the content builds and the "riddle" remains unanswered until the end of the passage, where the machine is identified as a phonograph. (See Langer, in press, for a detailed analysis of these characteristics of this passage.)

After reading the passage, 13 of the 24 students had constructed envisionments of some kind of voice-playing machine, and three knew it was a phonograph. (The others

knew about record players and stereos, but did not know what a phonograph was -- it was not in their understanding vocabulary.) Another 5 knew it was a machine with voice or word producing properties, but the voice aspect wasn't constant in their envisionments. (This uncertainty resulted in part because a modern-day record player does not have the voice recording function described as a property of the old machine.) Another 6 students knew it was a machine, but they failed to find any way to integrate the properties described in the text into a single representation.

Of the six questions that followed the passage, three (10, 11, and 12) appear to tap local envisionments while the other three (13, 14, and 15) appear to be based upon the final integrated envisionment. As reported in our previous work on testing (Langer, in press), unknown (or difficult) words sometimes appear in test questions even though they do not appear in the text, and these cause question-answering problems. In the case of question 10, 18 of the children provided open-ended responses that were consistent with the passage (14 chose "surprise," 2 "happy," 1 "glad," and 1 "excited"). When the multiple-choice options were presented, however, only 1 student knew the meaning of the intended correct response ("astonished"). Twelve other children also chose "astonished," but did so without understanding its meaning: "This must be right, the others

don't make sense." "This is the only one I don't know and the others are wrong." "The people weren't worried or frightened about the machine, they liked it." Rather than drawing on the local envisionment this question seems to tap, these students seemed to be relying on their final envisionments of a modern-day voice-playing machine that brings pleasure to people.

The four students who chose "frightened" seemed to separate their envisionment of the present-day voice-making machine (that's nice and good) from its ancestor, the strange machine of long ago. That strange machine had tubes and tin, and handles -- and could have frightened people. They said, "It was different. People were afraid of that machine. It was strange and they were frightened." These students seemed to return to an earlier more local envisionment of the old machine, but to do so they had to separate it from the integrated notion of the pleasure-giving present-day "voice box."

The second question, about the part that moved when the handle was turned, also seems to focus on a local envisionment. To answer it correctly, students needed to separate their understanding of a present-day phonograph (which was part of their final envisionment) from the details of the local envisionment--particularly two references to the moving tube. In response to the open-

ended version of this question, 12 of the 24 students responded with "needle," 3 with "tube," and 2 with "tin." When asked why they answered "needle," it became apparent that these students were relying on their integrated envisionments. They said, "The needle moved to make the voice." Their images of the voice-playing machine of today (record player, stereo) clearly still had a needle, but not tubes or mouthpieces - at least not in their envisionments.

When selecting among the options in the multiple-choice version, 13 chose "tube," 9 chose "needle," and 2 chose "mouthpiece." Those who chose "tube" checked with the surface text and said, "Here it says...." The others chose "mouthpiece" as part of a tape recorder or "needle" as part of a record player. Although they did not know what a phonograph was, their envisionment of the present day machine was sufficiently well developed that they could rely upon their own integrated knowledge. In this case, it got in the way of the "correct" answer.

Question 12, about the function of the needle as it pressed into tin, also appears to tap local knowledge. Although most students had difficulty in answering the open-ended version of this question (2 said "giving its age" and 1 said "still", while the rest did not respond), when shown the choices 18 correctly chose "recording a voice." Although their envisionments had not all come together in the form of

a stable voice-playing machine, the choices offered in this question made sense in terms of their final envisionment. They said, "Because that was what the passage was about." In this case only one student referred back to the text for evidence by saying "It says it was playing back your words."

The three questions discussed above seemed to focus on readers' use of local envisionments in responding to test questions. It has been interesting to observe that although the questions appeared to be more local in nature, most of the readers relied on their final integrated envisionments to respond to the tasks. They seemed to resort to data from a local envisionment only when "stuck" or pressed to do so by the testing situation.

Question 13, asking what first appeared in 1877, appears to tap final integrated envisionment. (It is somewhat like a question designed to test concept learning where the text provides clues in riddle form and the question checks to see if that concept has been guessed.) When presented with the open-ended version of the question, eight students gave a reasonable response, "machine," based on their final envisionment. Six others relied on their local envisionments for parts ("tin," "needles," or "tubes"). When shown the multiple-choice selections, 19 of the 24 students chose the correct response. Although only three knew what a phonograph was, the rest did know it was a

machine. Six students lifted the unknown machine word (phonograph) from the text as a visual match, but 13 knew it was the only word referring to an entire machine, and that it was an entire machine that had appeared in 1877. They said, "I don't know what that word means but it's the answer." "The other things didn't appear in 1877." "It's the whole machine, not just a part." The five students who chose incorrect responses ("tin," "needles," "tubes") said "I don't know what that means (phonograph) but my answer was part of the machine that appeared in 1877." These students (like those in the previous questions) seemed to separate their integrated envisionment of the machine from an in-process, localized envisionment made up of the separately described parts.

Question 14 also appears to tap an integrated final envisionment, asking what the story as a whole "tells about the machine." Of the 24 students, 18 provided reasonable responses to the open-ended version of the question; all of these relied on the final envisionment ("what it looks like," "how it worked," "how it was"). Two other responses were more locally based ("the tubes" and "it played your voice"). Twenty one students selected the correct response when shown the choices, all by drawing on their final envisionments. They said, "It just tells you all the things it does. That's what it was about."

Question 15, asking what the story is "mainly about," appears to tap integrated knowledge, though this is complicated by these students' lack of understanding of the word "phonograph," which was not included in their final envisionment of the machine. Thirteen students answered "machine" when presented with the open-ended question; of these, only 4 changed their guesses to "phonograph" when shown the choices. In all, twelve students got the answer "right" by choosing "phonograph" (10 chose machine, and 2 refused to choose at all).

For most of the 22 students who chose "phonograph" or "machine," the machine was what the passage was about. The text supports the notion that it was a machine and the question itself refers to it in this way. It is only the "name" of the machine that is missing. In this case, their integrated knowledge should have helped the students, but only those who resorted to the visual match provided by local text got the question right.

Bronco. Responses of these same 24 students to the Bronco passage (see figure 3) provide an interesting contrast. This passage has only two questions, and both appear to tap the reader's final integrated envisionment. The passage is brief, stating, in essence, that a bronco buster must keep one hand in the air, or be disqualified.

The interesting complexities in this particular item occur not so much in the students' envisionment-building, but in their use of that envisionment in responding to the questions. Because the students were asked to "act out" their text understanding as part of the probing after the second sentence in the passage, we had an opportunity to learn how they imagined the "hand-in-air" action to occur. (A detailed analysis of this passage is presented in Langer, in press.)

After reading the Bronco passage, 18 students had constructed envisionments of a person riding a "wild" animal in a contest that required one hand be held in the air. Of these, 8 understood the penalty for disobeying the rules would be disqualification from the contest (the other 10 were uncertain about the significance or tenure of "disqualification"). The remaining 6 knew the passage was about an event that required someone to hold one hand in the air while riding something (a horse, a bull, a cow, a Ford bronco) but failed to integrate the rodeo contest properties presented in the text.

All 24 students knew what "rules" were, and although 5 had no sense of the word "disqualified" (another 5 had only a rudimentary sense of the meaning), all knew something about getting "kicked out" for non-compliance with rules. All 24 had envisionments of someone riding something--with

one hand in the air and the other holding on to something. Eleven students were unfamiliar with the word "ignores" (which occurred in the first question but not in the passage) and 5 were unfamiliar with the meaning of "free" as it was used in the second question.

In responding to the open-ended version of the first question (about the consequences of ignoring the rules), 13 of the 24 students correctly reported that the rider would be "disqualified." Nineteen students (including the 13 who got the open-ended version correct) chose "disqualified" when shown the multiple-choice version of the question. Eight of the students indicated their choice was based on a visual match by pointing to the word "disqualified" in the passage and saying, "It says so here." The others used their final envisionments to select "disqualified," explaining, "He's disqualified cause he just ignores the rules" or "That's what happens, you get kicked out if you don't obey the rules." "That's just what happens." The remaining 5 students chose "skill" or "winner." The students who chose "skill" did not know the word "ignores" but based their choices on their final integrated envisionments of skilled bronco busters. They said, "Cause you gotta be skilled and good at it." Those who chose "winner" used their "social" knowledge to reason that if you cheat you'll probably win--"If you don't follow the rules you'll cheat and have a

better chance to win." With the exception of the 8 students who based their responses on a visual match, the students seemed to rely on their final integrated envisionments in their efforts to answer this question.

Question two, which asks where the bronco buster must keep one hand, also appears to tap the final envisionment. After reading the open-ended question stem, 21 of the 24 students provided an appropriate answer, "in the air" or "up." On the multiple-choice version, the corresponding response was "free," and this was chosen by 18 of the students. Since they had been asked to "act out" what the bronco buster was required to do, it was evident that the students all had envisionments of the bronco buster with one hand in the air and the other hand holding on to something. The students who selected responses other than "free" appeared to do so because they were unfamiliar with that use of the word "free." They said, "One hand has to be in the air, so the other hand can't be free or you'll fall off." "If your hand is free it just hangs there and you've gotta make both hands work so you won't fall off." After rejecting free as a choice, 5 students used their integrated envisionments to choose "hold." They reasoned, "If you don't hold, you'll fall off." "If one hand is in the air, you'll have to hold on with the other one." "You know, you gotta do a handhold." Another student chose "still,"

reasoning, "if you don't hold one hand still, you'll fall off."

The students' responses to the open ended and multiple choice questions provide an interesting contrast in the kinds of knowledge sources they call upon when formulating and choosing their answers. Despite the question type, be it local, global, literal, or inferential, the student self-reports indicate a direct attempt to respond meaningfully--to use the knowledge of what they had read to answer the questions. Further, they demonstrated a general tendency to rely upon their final envisionments as their primary source of knowledge in answering questions. Although successful readers should be flexible in their use of a variety of meaning-getting strategies and rely on a number of knowledge sources, the fact that all of our readers relied on their final envisionments most of the time is an interesting point of information. It suggests not only where to start in understanding students' comprehension strategies, but also raises a host of research questions about how their final envisionments can be used most effectively, and what other knowledge sources are useful for what purposes.

General Patterns in the Responses

Patterns of response to individual items suggest the complexity involved in the comprehension process and the

difficulties involved in comprehension testing. In the section that follows, we will look at the extent to which more general patterns can be discerned in the student responses. We will also examine relationships between those patterns and the classification of the questions as literal/inferential or local/global. The following analyses look at: 1) the knowledge sources that guide responses to open-ended and multiple-choice questions, 2) differences in the knowledge sources used to inform correct as opposed to incorrect responses, 3) the accuracy of the selections students make, and 4) the relationship between knowledge sources used and the presence of the correct concept in the local envisionment.

Knowledge Sources. First, we examined students' explanations of their responses to both the open-ended and the multiple-choice version of each question. Four sources of the responses were evident: 1) an earlier local envisionment, 2) the final envisionment, 3) a return to the text to find the answer, and 4) puzzling-out behavior--a reasoning process not based on the envisionment itself but on guessing what is "wanted." Results of applying these categories are presented in table 1.

Results for the open-ended questions indicate that when students were able to respond at all, they relied overwhelmingly on their final integrated envisionments.

The multivariate analyses indicate some difference in patterns of response; this reflects the fact that local questions were somewhat more likely to be answered on the basis of local envisionments ($F=8.38$, $df=1,23$, $p<.008$) and global questions were more likely to invoke a return to the text ($F=4.52$, $df=1,23$, $p<.05$).

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insert table 1 about here

If we look at the sources of answers to the multiple choice questions, the final envisionment continued to dominate all categories. The multivariate results, however, indicate some differences in the patterns for both local/global and literal/inferential categorizations. The local questions invoked more puzzling out of the answers ($F=18.94$, $df=1,23$, $p<.001$), while the global questions led to more reliance on the final envisionment ($F=15.76$, $df=1,23$, $p<.001$). The literal questions led to more reliance on a return to the text ($F=3.92$, $df=1,23$, $p<.06$), and less use of local envisionment ($F=5.21$, $df=1,23$, $p<.03$).

Two points seem important in these results. First, they challenge the assumption that literal questions are text-based, and hence easier to answer. Instead, even for literal questions, the students seemed to follow the more general pattern of reliance on their final envisionments. Second, the wider variety of strategies adopted in response

to the multiple choice items may indicate that these items are more responsive to test-taking skills, and less sensitive to normal comprehension processes.

Correct vs Incorrect Responses. The next set of analyses compared the knowledge sources students used in arriving at correct answers to the multiple-choice items with the sources used in choosing incorrect answers. Results are presented in table 2.

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insert table 2 about here

Results indicate that the correct responses, whatever the question category, were arrived at through use of a local or final envisionment. The local/global distinction had some effect on overall performance, due largely to a tendency for local questions to invoke more puzzling out of the correct response ($F=11.91$, $df=1,22$, $p<.002$).

Wrong answers followed a different pattern that varied with question type. Responses to local questions were more likely to be arrived at through puzzling ($F=13.01$, $df=1,12$, $p<.004$) or returning to the text ($F=7.84$, $df=1,12$, $p<.016$), and less likely to have depended on a local or final envisionment ($F=28.6$, $df=1,12$, $p<.001$).

Sources of wrong answers also varied when questions

were classified as literal or inferential. In this case, students were much more likely to have arrived at wrong answers to literal questions by returning to the text (33% of the time versus 0 percent for inferential, $F=6.60$, $df=1,12$, $p<.025$), and more likely to have arrived at wrong answers to inferential questions through puzzling (41% versus 20% for literal questions, $F=16.63$, $df=1,12$, $p<.002$).

Proportion of Right Answers. Analysis of the students' answers to both open-ended and multiple-choice questions indicates that their answers to local questions were incorrect more often than were their answers to global questions (see table 3).

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insert table 3 about here

On the multiple choice questions, the literal/inferential distinction did not appear to be related to question difficulty; students answered 71% of the inferential and 67% of the literal questions accurately. On the open-ended questions however, the pattern is more complicated. Overall, the students were more likely to give correct answers to literal than inferential questions ($F=147.11$, $df=1,23$, $p<.001$). This was largely an artifact, however, of their inability to respond at all to some of these questions ($F=91.56$, $df=1,23$, $p<.001$). What seems to have happened is that the language of at least two inferential questions (13

and 14: " Which of these first appeared in 1877?" and "Which of the following does this story tell about?") made them dependent upon the specific choices offered. Since the choices were not available in the open ended versions, it is not surprising that so many of the students were unable to form their own responses; they needed the actual choices before them.

Effect of Local Envisionment Because we had traced students' developing understanding of these passages, it was possible to compare the way in which they went about responding to a test question with their understanding of the text material on which the question was based. If the information had been present in the local envisonment (and thus been available for integration into the final envisionment), were they more likely to rely on the final envisonment in answering these questions?

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insert table 4 about here

In answering all question types, the students more often relied on their final envisionments as a knowledge source if the relevant concepts had been in their local envisionment during the reading process (see table 4). If it was not in their local envisionments, the students still relied heavily on their final envisionments, but some

returned to the text or attempted to puzzle out the answer.

More particularly, in responding to global questions, the students continued to rely heavily on their final integrated envisionments to arrive at a response, whether or not the concept had been in their local envisionment. In responding to local questions about concepts that had been in their local envisionments, however, they were likely to rely instead on puzzling ($F=23.07$, $df=1,21$, $p<.001$), or on a return to the text ($F=3.88$, $df=1,21$, $p<.06$), and less likely to use their final envisionments ($F=4.23$, $df=1,21$, $p<.05$).

Student responses to literal and inferential questions followed a similar pattern for concepts that had been in their local envisionments. However, for concepts that had not been in their local envisionments, the students used the text 46% of the time for literal questions (compared with 9% for inferential questions, $F=4.50$, $df=1,13$, $p<.05$)), and puzzling 27% of the time for inferential questions (compared with 8% for literal questions, $F=5.69$, $df=1,13$, $p<.03$).

Four conclusions seem justified from the examination of response patterns across questions: 1) whatever the goal or level of the question, the students consistently used their final integrated envisionments to arrive at their responses to both open-ended and multiple-choice versions of the questions; 2) even when they chose an incorrect response, most students searched their final envisionments in an

attempt to find the answer; 3) more correct responses were given for questions calling upon final as opposed to local envisionments; and 4) when a pertinent concept had not been in the local envisionment and the question was global, students tried to "figure it out" using their final envisionments, but when the question was local they were as likely as not to use other sources in searching for a response.

Discussion

This study questioned whether some items included in standardized multiple-choice reading comprehension tests are based on local envisionments--on knowledge whether directly or indirectly stated, that is evident in the reader's envisionment at a single point in time but that is radically changed or entirely absent from later envisionments. Further, it questioned whether real student readers tend to remember, or think first of, the final (as opposed to local) envisionments in their attempt to answer the range of questions.

Our results answer both questions in the affirmative. On the questions we analyzed, there appears to be a clear distinction between those questions that tap local and those that tap final envisionments. Also, the readers we interviewed tended to use their final envisionments as their

initial source of knowledge in answering all types of questions. Further, results suggest that questions which require the student to call upon previously used (but later changed or discarded) local envisionments may be more difficult to answer than those that are based on the reader's final envisionment.

The development of reading comprehension questions based on local and final envisionment knowledge sources appears to be a promising new direction in reading research. Since the majority of responses to global questions appear to come from the reader's final envisionment whether or not the question is answered correctly, student responses to global questions may turn out to be the best indicators of overall comprehension. It is also interesting to note that more students seemed to correctly answer the global as opposed to local questions. Although surprising from a more traditional view of question difficulty, this finding is particularly supportive of the constructivist notion that the understandings along the way are important primarily as they contribute to the reader's final text world--to the integrated knowledge and the many unanswered questions the reader is left with after having completed the reading of any text. (The complications in question-answering revealed in studying the detailed responses to individual test items are particularly interesting here, since item-difficulty is

also in part an artifact of test-construction procedures.)

This paper has raised a number of questions about the traditional categories used to describe levels of complexity in comprehension. The examples presented are typical of other test items analyzed in the larger study from which these data were drawn, and the student responses are typical of others collected. Further analyses of the usefulness of existing hierarchies, as well as of the usefulness of the notions of local and final integrated envisionments in describing ways in which readers comprehend texts, are of course necessary, and should be undertaken. Of particular importance for further research is the distinction between local and final integrated knowledge sources as well as local and global question types. Although we have not addressed the issue in this paper, it is likely that the addition of a third category, "integrated local knowledge" would be a useful third distinction. It is likely that the local category as defined for this study includes two distinct kinds of knowledge, one more fleetingly local and one more integrated. Although we have not addressed this distinction in the present paper, future studies might attempt to see if these can be defined and analyzed as two separate categories.

Still, the reader-based analyses reported here provide powerful evidence that the questions used to assess reading

comprehension, when examined from the perspective of the reader's developing text world, are more appropriately described by the local/global distinction than by the more traditional categories. Students do not appear to act on the assumptions that underlie the literal/inferential distinction, and therefore interpretations of student performance in terms of these assumptions can be misleading.

From data such as have been presented here, we may come to regard the other taxonomies not as wrong, but as irrelevant to the measurement of comprehension processes. Further, the questions raised here suggest that our more traditional taxonomies may be limiting for both researchers and teachers. They may inhibit us in more ways than we realize -- in the questions we generate, in the responses we accept as correct, and in our understandings of which questions invoke more or less complex cognitive avtivity, and why.

I. In 1877, a machine appeared (LO(I) time adverbial, indefinite article, past tense, no final punctuation)

1. Sch(Co) MACHINE (includes parts, functions, usually is constructed of metal, breaks down)	1) How can you tell if something is a machine?
2. Sch(Co) APPEAR a) sudden presence, often subject is strange, ghostly, etc. b) subject is an invention which is being marketed, 'appears' on market c) = 'seem' has sentential or adjectival complement	2) What do you think they mean by 'appear?' How do you picture this scene?
3. Sch(Gn) historical account beginning with date of incident	3) What kind of machine do you they had in 1877?
4. Q(Co/TX) Is this machine a specific topken or is it a generic representative?	4) Are they talking about just one machine here?
5. H (Tx) We will read about: a) a specific machine that appeared suddenly as in 2a, b) the invention and use of some type of machine, c) an infinitival complement or an adjective describing the role or appearance of a) or b) above.	5) What do you think the rest of this sentence will say?
6. H (Gn) This is expository	6) What kind of piece do you think this is?
7. H (Co) This will be about a machine	7) What do you think this passage will be about?

Figure 1. Analysis of Strange Machine (opening segment).

In 1877 a machine appeared which surprised many people. Can you guess the name of this strange new machine?

As you spoke into the mouthpiece and turned a handle, a tube covered with a thin piece of tin moved around. As the tube moved, a needle pressed deep lones into the tin. As you turned the handel one more, the needle touched against the same lines and played back your words.

This was the first phonograph! How different from the hi-fi of today

10. How did the people feel when they saw this new machine?
    5) angry 6)astonished 7)worried 8) frightened
    (local)

11. As the handle was turned, which part of the machine moved?
    1)tube 2) needle 3) press 4) mouthpiece
    (local)

12. As the needle pressed lines into the tin, it was
    5) giving a shot
    6) recording a voice
    7) painting a picture
    8) sewing a piece of material
    (local)

13. Which of these first appeared in 1877?
    1) tin 2) needles 3) tubes 4) phonographs
    (global)

14. Which of the following does this story tell about the machine?
    5) how it worked 6) who invented it
    7) where to but it 8) how many people saw it
    (global)

15. What is this story mainly about?
    1) guessing a name 2) speaking clearly
    3) the first machine 4) the first phonograph
    (global)

Figure 2. Strange Machine test item.

If a bronco buster wants to win a rodeo contest, he must observe the contest rules. One of these rules is that the rider must keep one hand in the air. A rider who does not do this will be disqualified.

1. A bronco buster who ignores the rules is
   1) skillful 2) disqualified 3) chosen 4) winner
   (global)

2. In a rodeo contest, a bronco buster must keep one hand
   1) in the air 2) still 3) free 4) hold
   (global)

Figure 3. Bronco Buster test item.

	local	final
literal	10,11	1,2
inferential	12	13,14,15
applicative	0	0
textually-explicit	0	0
textually-implicit	10,11	13,14,15,1,2
scriptally implicit	12	

Figure 4. Question by category type.

Table 1. Sources of Open-Ended and Multiple-Choice Responses

Mean Percent: Source of Open-Ended Responses	Basis of Question: Local M	Local SD	Global M	Global SD	Literal M	Literal SD	Inferential M	Inferential SD
local envisionment	9.8	30.0	1.5	12.4	5.3	22.5	3.3	18.3
final envisionment	87.8	33.1	83.0	37.8	85.5	35.4	83.3	37.9
text	2.4	15.6	15.4	36.4	9.2	29.1	13.3	34.6
puzzling	0.0	0.	0.0	0.0	0.0	0.0	0.0	0.0
N Responses=	41		65		76		30	
Source of Multiple-Choice Responses								
local envisionment	0.0	00.0	3.3	18.0	0.0	00.0	4.2	20.1
final envisionment	55.7	50.3	79.2	40.8	68.1	46.9	72.9	44.7
text	17.1	37.9	12.5	33.2	20.2	40.4	8.3	27.7
puzzling	27.1	44.7	5.0	21.9	11.7	32.3	14.5	35.5
N Responses=	70		120		94		96	

Multivariate Analyses: Within Subject Effects	Open Ended Responses F	df	Sign	R^2	Multiple-Choice Responses F	df	Sign	R^2
Local/Global	7.67	2,22	.003	.41	9.53	4,20	.001	.66
Literal/Inferential	0.26	2,22	NS	.02	3.44	4,20	.027	.41
Interaction	0.78	2,17	NS	.08	0.77	4,20	NS	.13

Main effects tested after allowing for each of the other main effects.
Students who did not respond at all are omitted from the analyses.

Table 2. Sources of Correct and Incorrect Response

Mean Percent		Sources of Correct Responses					
		envisionment		text		puzzle	
	N Resp.	M	SD	M	SD	M	SD
Local	57	77.3	42.3	6.8	25.5	15.9	37.0
Global	57	83.2	37.6	15.7	36.6	1.1	10.6
Literal	57	78.1	41.7	14.1	35.0	7.8	27.1
Inferential	57	84.1	36.9	11.6	32.2	4.4	20.5
		Sources of Incorrect Responses					
Local	57	19.2	40.2	34.6	48.5	46.2	50.8
Global	57	80.7	40.2	3.2	18.0	16.1	37.4
Literal	57	46.7	50.7	33.3	48.0	20.0	40.7
Inferential	57	59.3	50.1	0.0	0.0	40.7	50.1

Multivariate Analyses:	Correct Responses				Incorrect Responses			
Within Subject Effects	F	df	Sign	R^2	F	df	Sign	R^2
Local/Global	6.04	2,21	.008	.36	13.21	2,11	.001	.71
Literal/Inferential	0.32	2,21	NS	.03	13.56	2,11	.001	.71
Interaction	0.78	2,17	NS	.08	3.18	2,8	NS	.44

Table 3. Accuracy of Responses

Mean Percent Correct	N Resp	Multiple-Choice M	Multiple-Choice SD	Multiple-Choice NR	Open-Ended M	Open-Ended SD	Open-Ended NR
Local	72	61.1	49.1	2.8	30.6	46.4	43.1
Global	120	74.2	44.0	0.0	41.2	49.5	43.3
Literal	96	66.7	47.4	2.1	60.4	49.2	19.8
Inferential	96	71.9	45.2	0.0	14.6	35.5	66.7

Multivariate Analyses

Within Subject Effects	F	df	Sign	R^2
Local/Global	10.23	2,11	.001	.48
Literal/Inferential	73.26	2,27	.001	.87
Interaction	1.26	2,22	NS	.10

Table 4. Response Sources Based on Concept in Local Envisionment

Source of Response / Question type	N Resp.	local M	local SD	final M	final SD	text M	text SD	puzzle M	puzzle SD	NR M	NR SD
In Local Envisionment											
Local	43	0.0	0.0	65.1	48.2	4.7	21.3	27.9	45.4	2.3	15.3
Global	91	2.2	14.7	83.5	37.7	12.1	32.8	2.2	14.7	0.0	0.0
Literal	72	0.0	0.0	75.0	43.6	11.1	31.7	12.5	30.7	1.4	11.8
Inferential	62	3.2	17.8	80.6	39.8	8.1	27.5	8.1	33.3	0.0	0.0
Not in Local Envisionment											
Local	29	0.0	0.0	37.9	49.4	34.4	48.4	24.1	43.6	3.4	18.6
Global	29	6.9	25.8	65.5	48.4	13.8	35.1	13.8	35.1	0.0	0.0
Literal	24	0.0	0.0	41.7	50.4	45.8	50.9	8.3	28.2	4.2	20.4
Inferential	34	5.9	23.9	58.8	50.0	8.8	28.8	26.5	44.8	0.0	0.0

Multivariate Analyses

Within Subject Effects	F	df	Sign	R^2	F	df	Sign	R^2
Local/Global	8.88	4,18	.001	.66	2.87	4,10	.08	.53
Literal/Inferential	1.04	4,18	NS	.19	6.30	4,10	.008	.72
Interaction	0.96	4,15	NS	.20	0.28	4,6	NS	.16

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